AD-A132 087

NSWC TR 83-8

REACTION PROPAGATION ALONG AN ENCLOSED CONVEYOR

BY MICHAEL M. SWISDAK, JR. PHILLIP J. PECKHAM

RESEARCH AND TECHNOLOGY DEPARTMENT

5 DECEMBER 1982

NAVAL SURFACE WEAPONS CENTER

Dahlgren, Virginia 22448 • Silver Spring, Maryland 20910

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NSWC TR 83-8	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) REACTION PROPAGATION ALONG AN ENCLOSED CONVEYOR		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Michael M. Swisdak, Jr. Phillip J. Peckham		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Surface Weapons Center (Code R15) White Oak Silver Spring, Maryland 20910		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS OPN;0;0;R15HA
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE 5 December 1982
		13. NUMBER OF PAGES 46
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release, distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

McAlester
Bomb Loading
Conveyor
Explosions
Tests

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Tests were conducted to study the likelihood of explosive reaction propagation along an enclosed explosive handling conveyor. An initiation scheme was selected and tests conducted which insured a high order detonation over the entire length of an explosive increment. A full scale mockup of a 125-foot enclosed section of conveyor was constructed. A 50-foot increment of explosive was detonated. A 25-foot air gap and a 50-foot acceptor increment were also present. The acceptor did not detonate, nor even react violently. A small amount of self-extinguishing burning was also observed.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

S/N 0102-LF-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

FOREWORD

This report presents the results of a test program conducted by the Explosion Dynamics Branch (R15) of the Energetic Materials Division (R10) for the Facilities/Equipment Branch (Code 6412) of the Naval Sea Systems Command. The problems addressed herein were raised in safety analyses performed by Hercules Aerospace Division, Allegany Ballistics Laboratory.

Company and trade names are used in this report for technical information purposes only. Neither endorsement nor criticism is intended.

The dedication and contribution of James Messick and Gruver Martin, to the successful completion of this program are sincerely appreciated. The construction of the conveyor and its enclosure as well as the fielding of the tests were under the guidance of the TERA group of the New Mexico Institute of Mining Technology.

Approved by:

J. F. PROCTOR, Head
Energetic Materials Division

CONTENTS

ILLUSTRATIONS

TABLES

CHAPTER 1

INTRODUCTION

BACKGROUND

In the early 1970's, the Department of the Navy began efforts to modernize and upgrade an existing bomb loading facility at the Naval Ammunition Depot (NAD), McAlester, Oklahoma. One of the innovative features of the modernized plant is the use of a belt conveyor to move the explosive ingredients from the unloading building to the mix-melt kettles. Many safety questions about such a system were raised. To address and answer these questions, a Safety Review Panel (SRP) was organized in January 1972.[1]

At the recommendation of this panel, a series of tests were conducted by the Naval Weapons Center (NWC), China Lake, California, to determine certain properties of the conveyor-based explosive handling system. These tests investigated in part the following:

1. the minimum bed depth for reaction propagation,

2. reaction propagation across an air gap,

3. reaction propagation between adjacent conveyors.

The China Lake experiments reached the following conclusions (among others):[2]

1. It is relatively easy to initiate a detonating reaction in flake TNT. Only an electric blasting cap is required. However, this type of energy input will be unlikely to occur in the powder handling areas of the proposed bomb line.

2. A 5-cm thickness of flake TNT will readily sustain a detonating reaction.

3. If the thickness of a patch of loosely piled TNT is approximately 2 to 3 cm or less, the detonation will probably not be sustained.

4. Flake Comp B does not detonate as readily as flake TNT.

---

[1]NAVORD letter ORD-0473/GMG:29 of 21 Jan 1972.

[2]"Safety Analysis of Proposed High Explosive Bomb Plant at NAD, McAlester," prepared by Naval Explosives Development Engineering Department, Naval Weapons Station, Yorktown, Virginia, Jan 1973.

5. Detonation of 50 mm deep Tritonal (80/20 TNT/Al) will not propagate from one charge across a gap of 14.3 meters (47 feet) or 7.16 meters (23.5 feet) to another charge of Tritonal constituents in a conveyor configuration.

6. A dual belt installation probably does not represent a greatly different problem to the design of the plant than a single belt does.

The China Lake work also introduced the following caveat: "These are free-air values--a conveyor enclosing could change them."

Based on the NWC tests and the safety committee recommendations, the conveyor design shown in Figure 1-1 was chosen. The belt has an overall width of 18 inches with an inside service width of 13 1/4-inches. The bottom surface of the belt carrying the explosive is located approximately 10 1/2-inches from the top of the container.[3] The conveyor is totally enclosed in a rectangular stainless steel structure 1/4-inch thick. The maximum explosive depth is maintained at 1.5 inches (or less). The explosive is dispersed in 50-foot increments with a 25 to 50 foot air gap between increments.

CONCERNS

Recent safety analyses[3] have raised several concerns about the previous tests and analyses performed for the "A" line modernization. These questions included the following:

1. reliability of the initiation system used in the original tests,

2. the effect of conveyor width on reaction propagation,

3. the effect of the protective enclosure on the severity and propagation of reactions along the conveyor.

In the NWC tests, detonation was started with an E-99 electric blasting cap. The adequacy of this detonation source was determined by detonating a 1/2-pint cardboard container filled with flaked TNT. A plywood witness plate was used to assess the results. The flaked TNT appeared to detonate. As a result, the remainder of the NWC tests used simply one or more blasting caps as the detonation source. The question has been raised as to whether or not a true high order detonation was achieved.

The NWC tests used an explosive width of 18 inches; the as-constructed system has an explosive width of 13 1/4-inches. As pointed out in Reference 3, Army data indicate[4] that there may be a conveyor width effect for high order propagation along conveyors. The McAlester "A" line conveyor width has not been tested.

---

[3]Hunt, R. G., and Groce, T. A., "Evaluation of Fire or Explosion Propagation on the "A" Plant Explosive Delivery Conveyors," Hercules Aerospace Division, Report No. A08338-520-03-041, Hercules No. 82-3, Jan 1982.

[4]Kukuvka, R. S., and Gandhi, K., "Critical Depth Tests of Composition B Flake," Technical Report 5014, Picatinny Arsenal, Nov 1976.

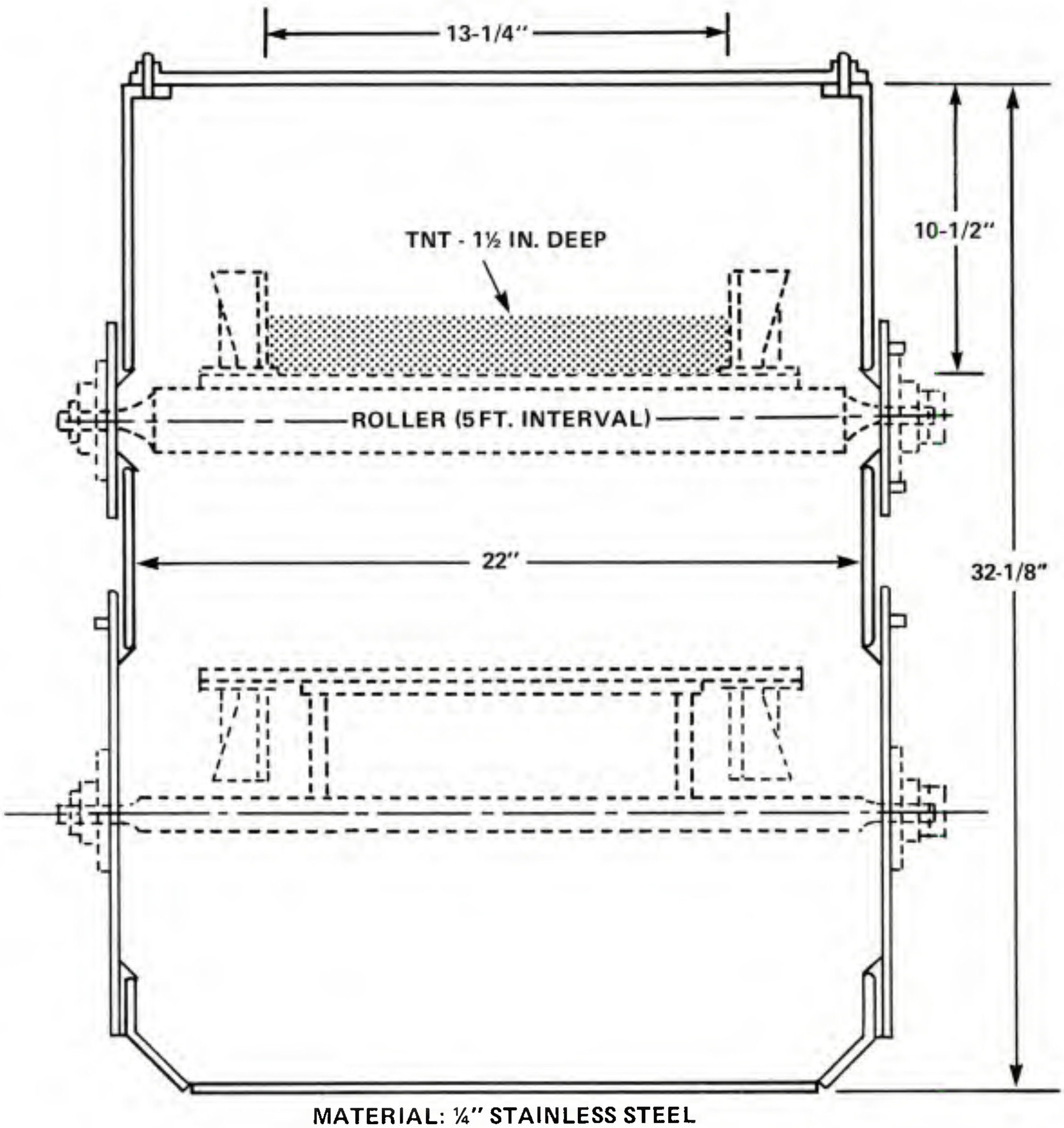


FIGURE 1-1. A PLANT CONVEYOR DESIGN

The total effect of the steel enclosure around the conveyor could not be determined. In general, the effect of an enclosure on explosive reactions is to increase the rate of reaction, the severity of the reaction, or both. It was felt that the enclosure could change a dying or non-propagating reaction into a sustained high-order detonation and moreover, allow the detonation to jump the gap between explosive increments.

During the conveyor experiments conducted at NWC, only lightly-confined conveyors were considered. The heavy, steel-enclosed conveyors were not envisioned and, thus, were not tested.

CURRENT PHILOSOPHY

With this background and concerns in mind, a new test program was devised by the Naval Surface Weapons Center (NSWC). The program would take as a "given," the unlikely event of a full detonation of one increment along a conveyor. The consequences of this event would then be investigated:

1. Would reaction propagate across the shortest gap actually proposed for McAlester (25 feet)?

2. What were the effects of the steel enclosure on the reaction?

To eliminate any questions about the effect of the conveyor width or material, actual conveyor material from the "A" line at McAlester was used for all the current tests.

CHAPTER 2

PRELIMINARY TESTS

INITIATION TESTS

A "given" in the program was the full, reliable detonation of one explosive increment along a conveyor. The detonability of flaked TNT was demonstrated by duplicating the NWC 1/2-pint container test. A 1/2-pint cardboard container was filled with flaked TNT and placed on a steel witness plate. A number 8 detonator was used as the detonation source. Based on the dent in the witness plate, it was surmised that the flaked TNT did detonate high order.

The next step was the achieving of a high order detonation of a distributed charge of flaked TNT. A trough, as shown in Figure 2-1 was used for two tests. In each case, the trough was filled with flaked TNT and detonated from both ends simultaneously. The aluminum plate in the center acted as a witness plate for judging the intersecting shockwaves from the two detonation sources. Two detonation schemes were tried, one using several layers of DETASHEET explosive and one using layers of Composition C-4. The deta sheet proved the more satisfactory. As a result of these tests, the initiation system depicted in Figure 2-2 was chosen. Four layers of DETASHEET, the height of the flaked TNT (1 1/2-inches) and the total width of the conveyor (18 inches) were used. The total DETASHEET weight was approximately 120 grams.

INSTRUMENTATION CHECK TEST

Because the full scale conveyor test was to include the steel enclosure, it was decided that a preliminary test would be held in the open. This would allow for instrumentation check-out as well as demonstrating that a high-order detonation was achievable over an explosive length of at least 25 feet.

The field setup for this shot is shown in Figure 2-3. Piezoelectric airblast transducers were used to monitor the airblast produced. Shock front location along the length of the charge was monitored with Dupont targets inserted into the explosive. These targets require pressures of over 30 kilobars before they respond.

A 25 foot section of conveyor material, supported by a wooden platform was used on the test. Approximately 175 pounds of flaked TNT were placed on the conveyor. Figure 2-4 shows photographs of the pre-test setup. The entire 25 foot length detonated high order. This was verified by all aspects of the instrumentation. The shock-front position-time (as recorded by the detonation velocity probes) indicated a sustained detonation at a rate of 10,300 feet per second. This data is presented in Table 2-1 and shown graphically in Figure 2-5. The high speed photographs showed a fireball typical of TNT detonations--a

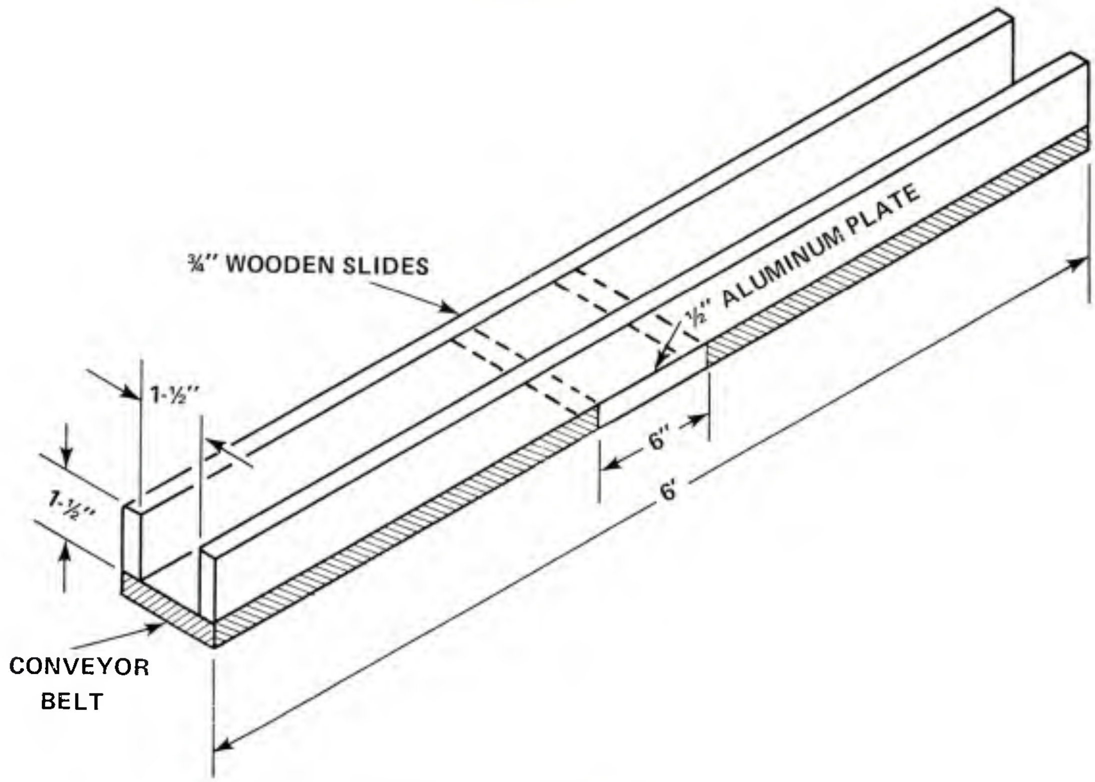


FIGURE 2-1. TROUGH USED FOR SMALL SCALE DETONATION TESTS

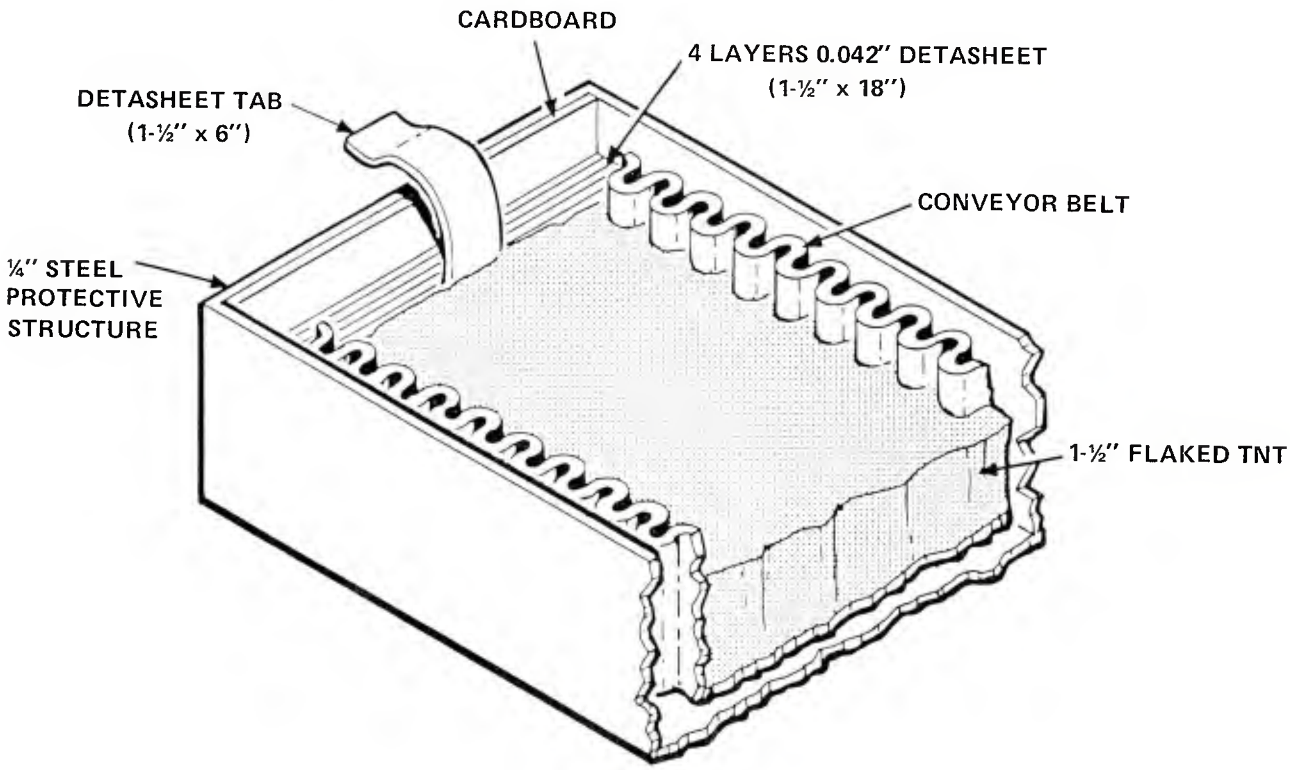


FIGURE 2-2. INITIATION SYSTEM USED IN CONVEYOR TEST

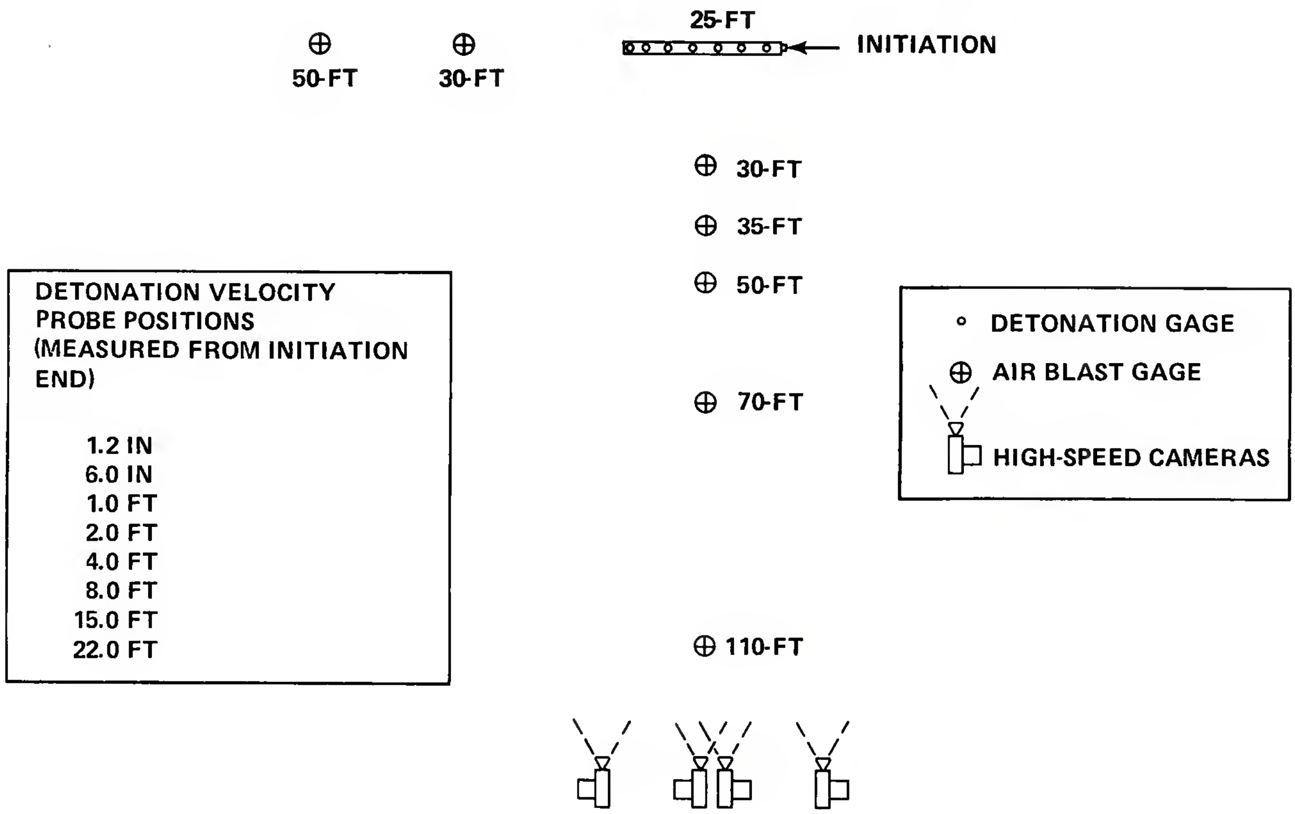
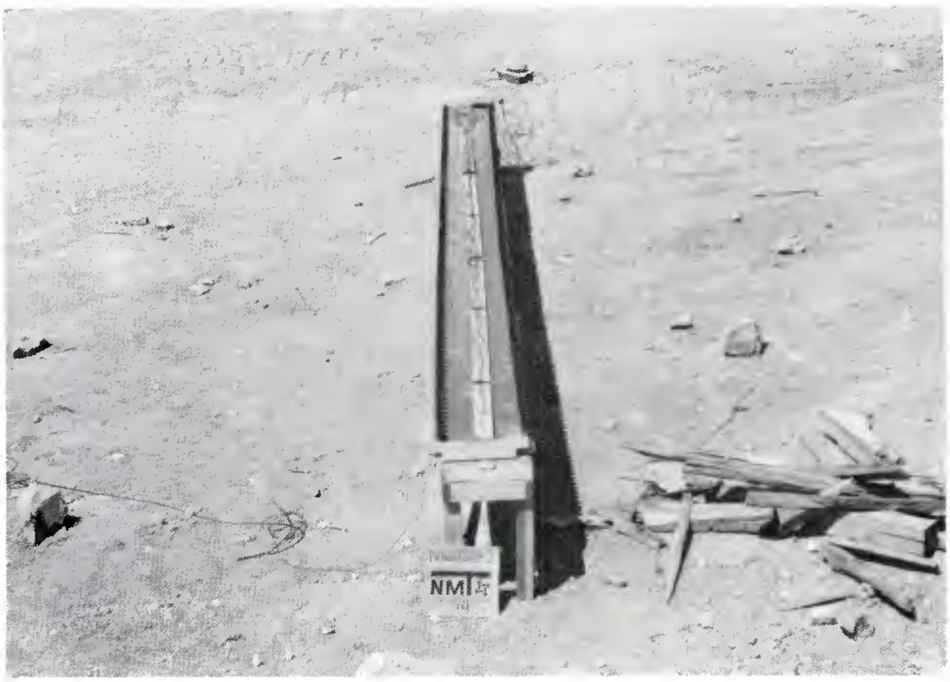


FIGURE 2-3. TEST SETUP FOR CALIBRATION TEST

(820722MS13)



(820722MS9)

FIGURE 2-4. PRE-TEST OF CALIBRATION SHOT

TABLE 2-1. SHOCK FRONT POSITION TIME (CALIBRATION SHOT)

Target Number	Polarity	Position* (ft)	Arrival Time** (Microseconds)
1	positive	0.1	14
2	negative	0.5	52
3	positive	1.0	106
4	negative	2.0	198
5	positive	4.0	388
6	negative	8.0	798
7	positive	15.0	1460
8	negative	22.0	2112

*Measured from detonation end

**Measured from detonation ignition

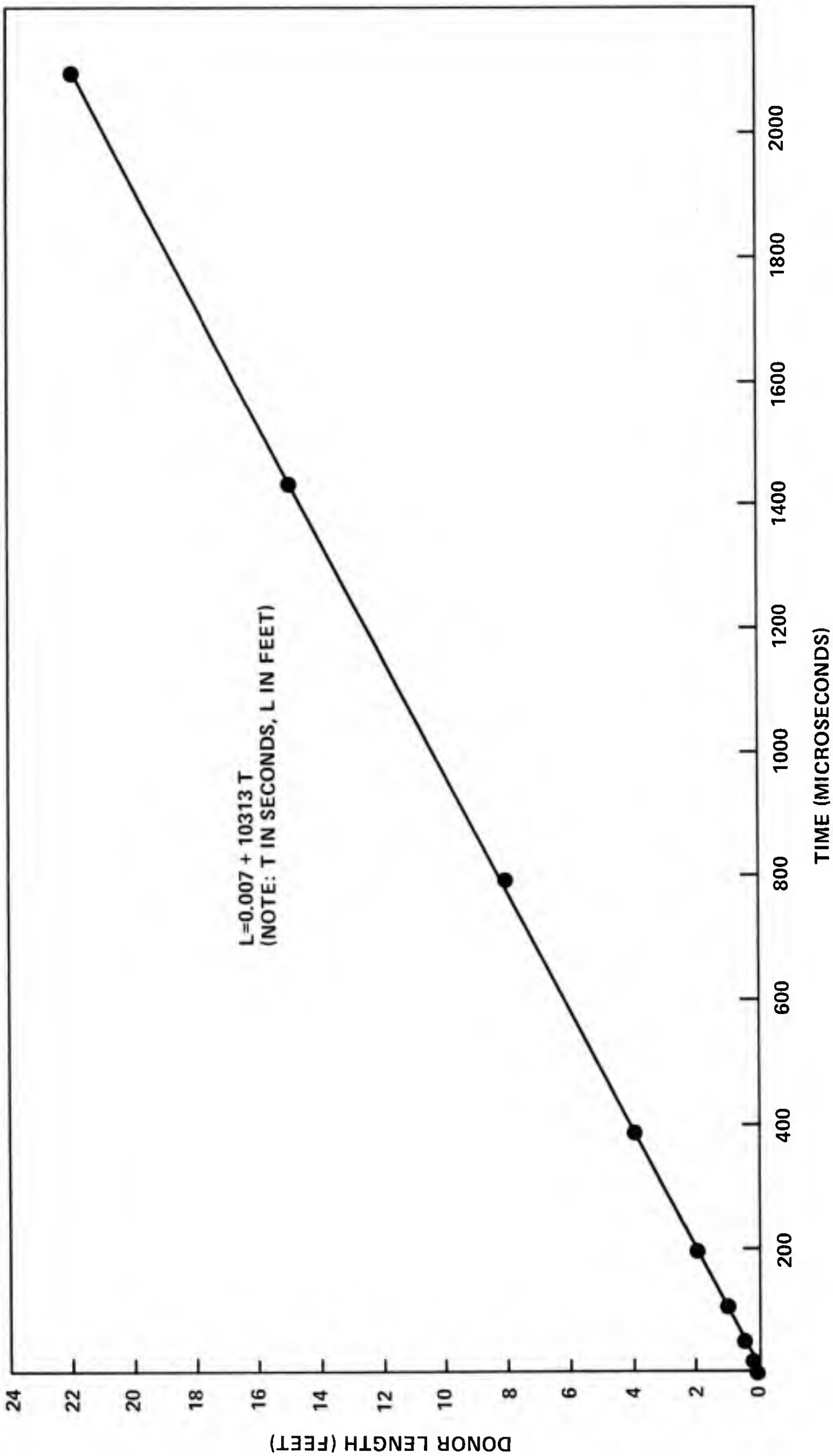


FIGURE 2-5. SHOCK FRONT POSITION-TIME (CALIBRATION SHOT)

bright white flash, followed later by a sustained burning. The airblast results recorded on this shot are presented in Table 2-2. Since the test site was at an altitude of approximately 5,200 feet, these results have been scaled to sea level conditions and are presented in Table 2-3. These sea level results are also shown in Figure 2-6. Appendix A presents the airblast pressure-time waveforms recorded on this test.

TABLE 2-2. AIRBLAST PARAMETERS MEASURED AT TEST SITE (CALIBRATION SHOT)

Channel	Angle*	Range**	Peak Pressure (psi)	Positive Impulse (psi-ms)	Positive Duration (ms)	Time of Arrival of Fragments (ms)	Time of Arrival of Shock (ms)
1-1	90°	30	17.0	----	----	12.95	14.20
1-2	90°	35	13.6	44.4	7.50	15.20	15.92
1-3	90°	50	10.4	39.5	12.25	24.40	29.22
1-4	90°	70	5.6	34.2	15.00	30.00	39.65
1-5	90°	110	3.0	21.8	20.25	49.55	70.90
1-6	180°	30	9.4	52.6	13.59		18.00
1-7	180°	50	3.3	----	-----		32.55

*0° is point of detonation
180° is off opposite end
**Measured from center of donor charge

TABLE 2-3. AIRBLAST PARAMETERS SCALED TO SEA LEVEL CONDITIONS (CALIBRATION SHOT)

Channel	Angle*	Range**	Peak Pressure (psi)	Positive Impulse (psi-ms)	Positive Duration (ms)	Time of Arrival of Fragments (ms)	Time of Arrival of Shock (ms)
1-1	90°	28.2	20.4	----	----	12.53	13.74
1-2	90°	32.9	16.3	51.5	7.25	14.70	15.40
1-3	90°	47.1	12.5	45.8	11.85	23.60	28.27
1-4	90°	65.9	6.7	37.6	14.51	29.02	38.36
1-5	90°	103.6	3.6	25.3	19.59	47.93	68.59
1-6	180°	28.2	11.2	61.0	13.15		17.41
1-7	180°	47.1	4.0	----	-----		31.49

*0° is point of detonation
180° is off opposite end
**Measured from center of donor charge

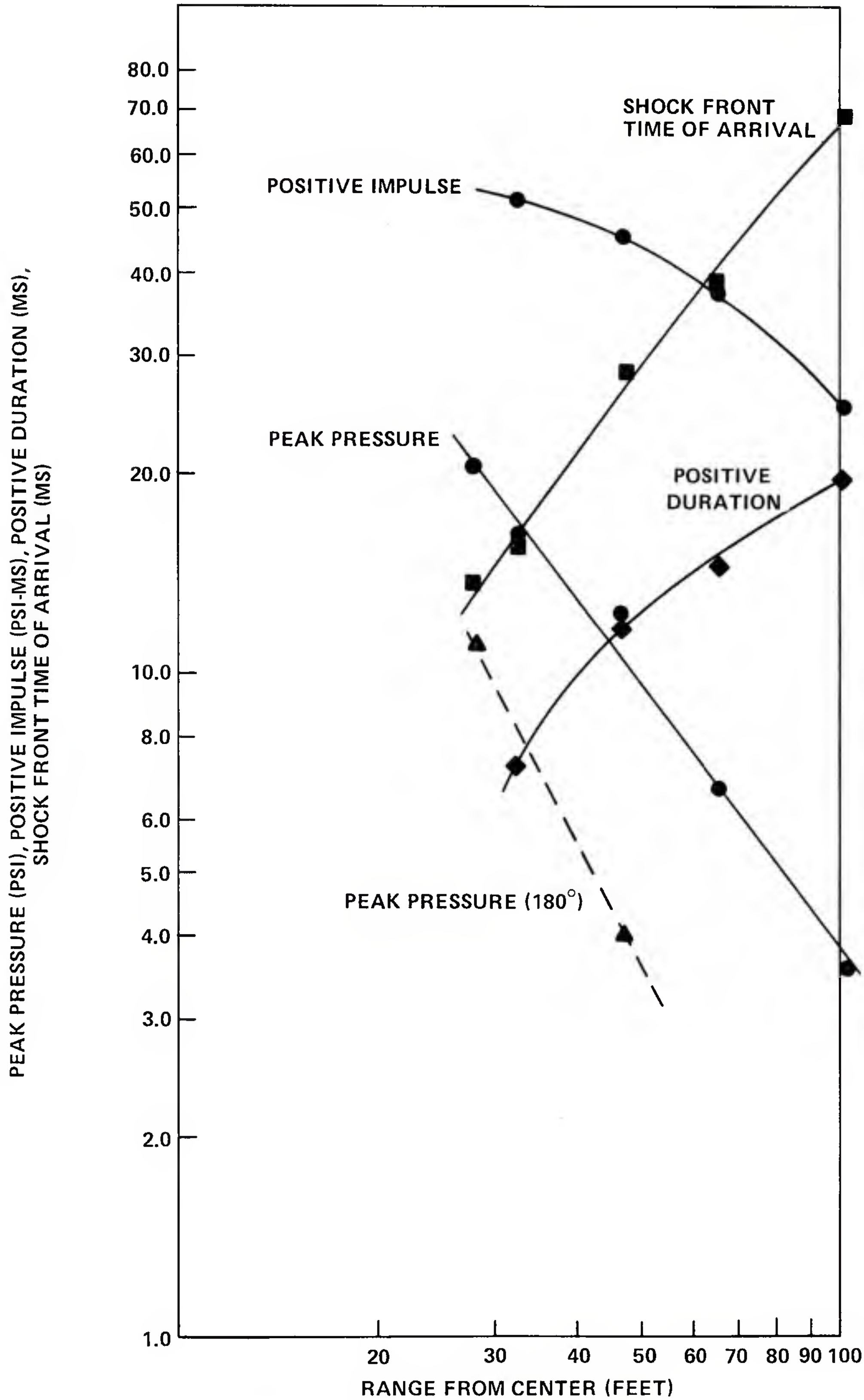


FIGURE 2-6. AIRBLAST PARAMETERS MEASURED ON CALIBRATION SHOT (SCALED TO SEA LEVEL)

CHAPTER 3

FULL SCALE TEST

CONSTRUCTION

Nearly all of the significant features of the "A" plant line were duplicated in the full scale test. Two 50-foot increments of TNT (each 1 1/2-inches deep) were used; each increment was separated by a 25-foot air gap. Actual conveyor belting from McAlester was used on the test. The internal details of the conveyor enclosure were somewhat simplified for this test. Figure 3-1(a) shows a cross-section of the McAlester enclosure. The rollers, bearings, and return conveyor were eliminated for this test. Moreover the enclosure was fabricated from mild steel, rather than the stainless steel used in the actual enclosure. Figure 3-1(b) shows a cross-section of the conveyor, as constructed for this test.

At McAlester, the top of each section of the enclosure is held on by hundreds of bolts. For this test, the top of each 10-foot section was constrained with bolts every 6-inches along the donor; the spacing was increased to 18 to 24 inches in the air gap and the acceptor.

Because the McAlester conveyor is inclined, the test conveyor was inclined at a 3° angle. Figure 3-2 presents a schematic of the completed conveyor. Figure 3-3 shows the completed conveyor as the lids are being emplaced. The same detonation scheme and instrumentation techniques that were demonstrated in the preliminary test were used on the full scale test. Figure 3-4 shows the test setup field layout for this test, while Figure 3-5 shows photographs of the pre-test setup. A total of 700 pounds of flaked TNT was used--350 pounds in the donor and 350 pounds in the acceptor.

RESULTS

The donor detonated high order over its entire 50-foot length; the acceptor did not detonate, nor appreciably burn.

High order detonation in the donor was confirmed by two methods, one optical and one electronic.

The electronic data utilized Dupont targets inserted into the TNT bed at fixed locations. Upon crushing of the target, a signal was recorded on a digital oscilloscope. The photographic data was recorded with a HYCAM camera operating at 10,000 pictures per second. This camera traced the fireball location along the length of the conveyor as the fireball broke through the enclosure. Both of these sets of position-time information are presented in

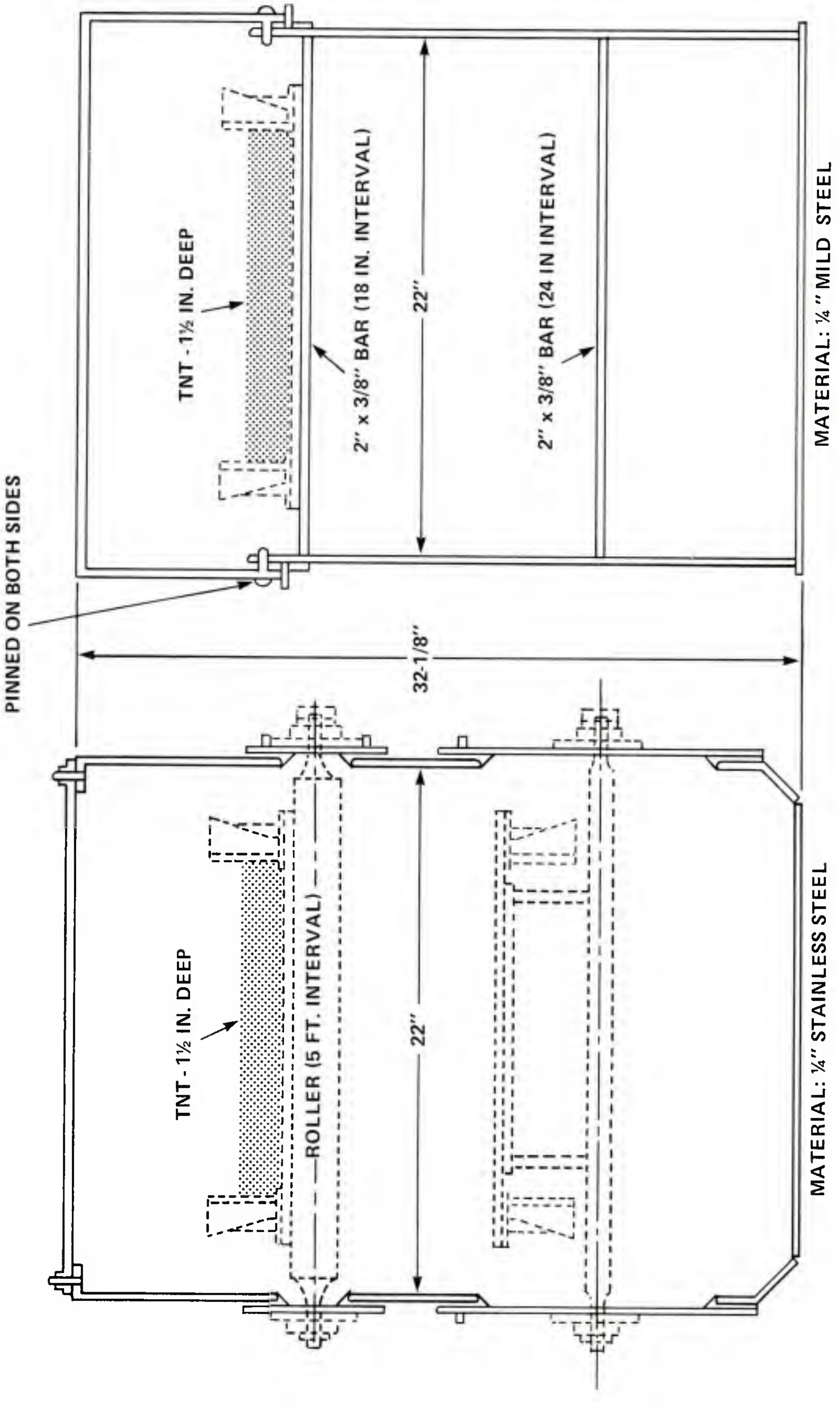


FIGURE 3-1. COMPARISON OF CONVEYOR CROSS SECTIONS

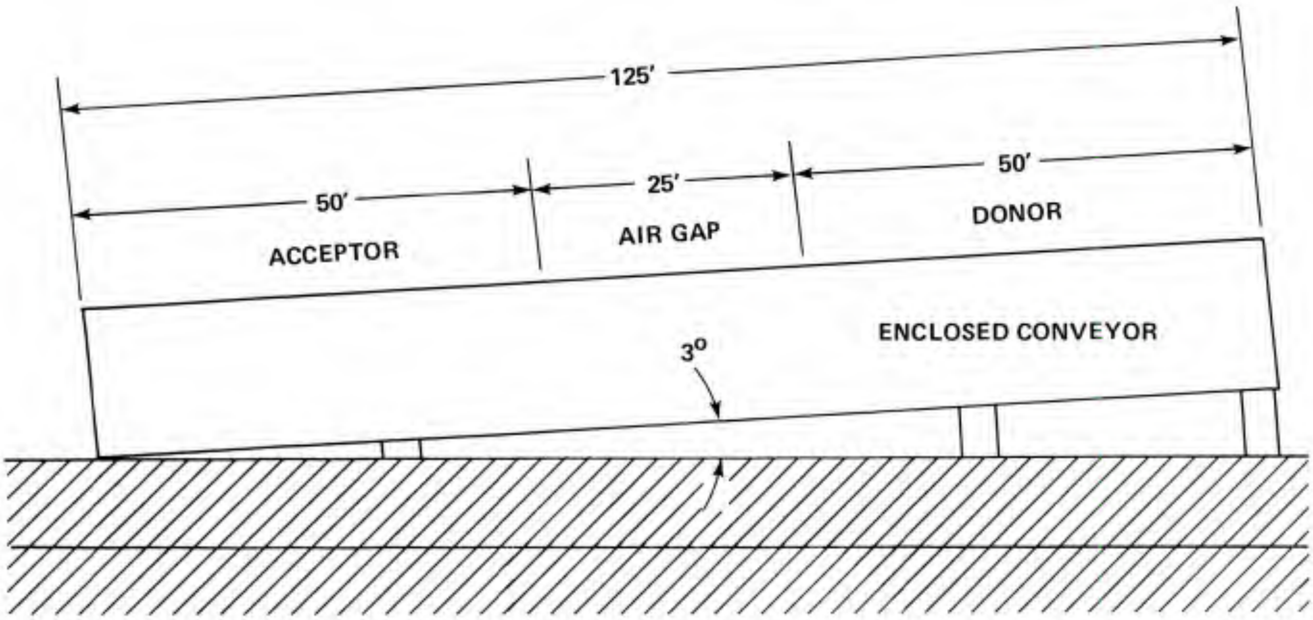
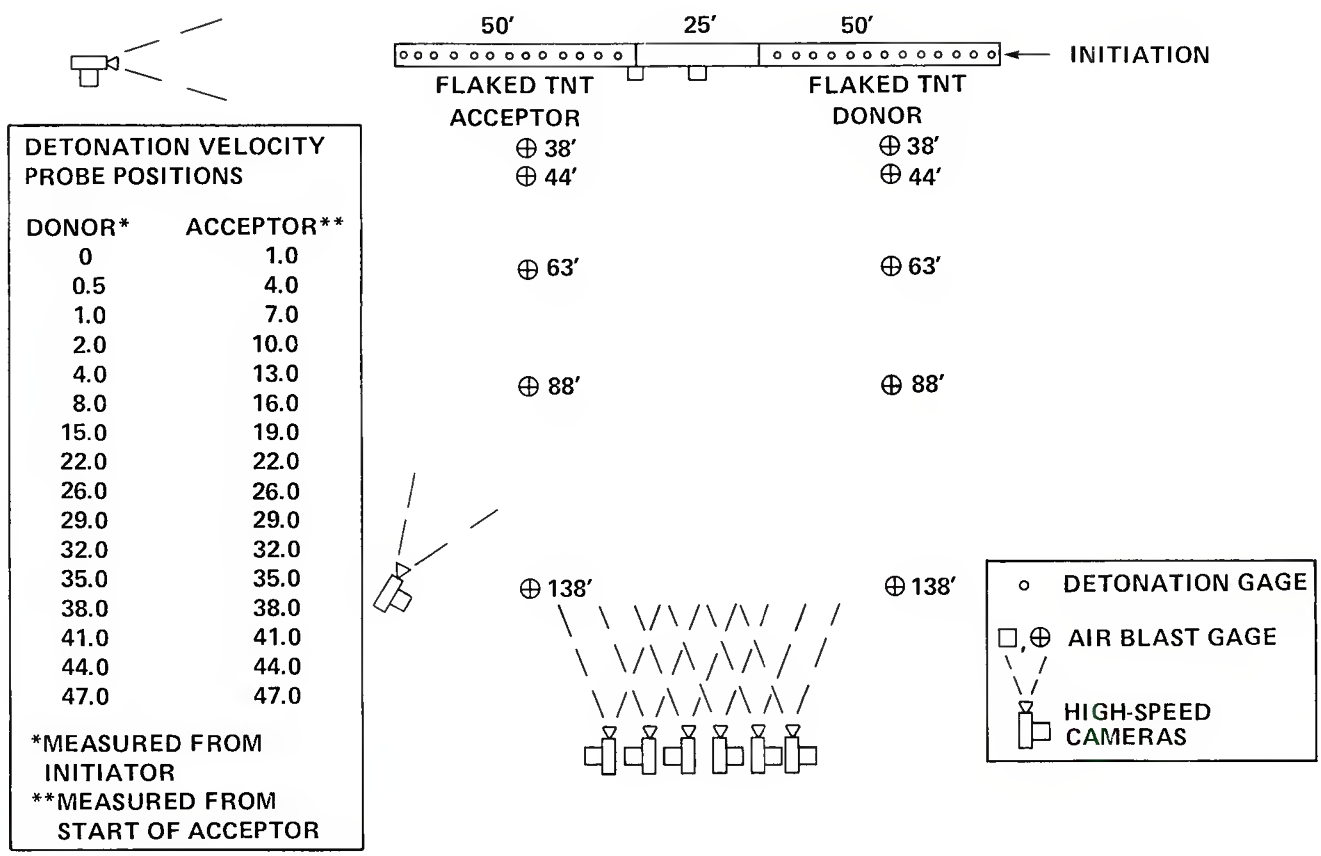


FIGURE 3-2. CONVEYOR SETUP

(820721MS16)

(820721MS17)

FIGURE 3-3. COVER EMPLACEMENT ON SIMULATED CONVEYOR



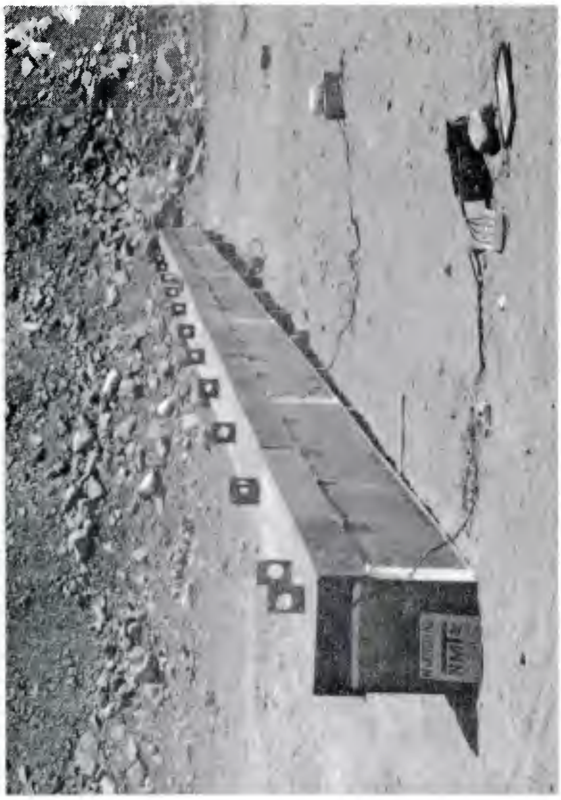
DETONATION VELOCITY PROBE POSITIONS

DONOR*	ACCEPTOR**
0	1.0
0.5	4.0
1.0	7.0
2.0	10.0
4.0	13.0
8.0	16.0
15.0	19.0
22.0	22.0
26.0	26.0
29.0	29.0
32.0	32.0
35.0	35.0
38.0	38.0
41.0	41.0
44.0	44.0
47.0	47.0

*MEASURED FROM INITIATOR
**MEASURED FROM START OF ACCEPTOR

FIGURE 3-4. TEST SETUP FOR CONVEYOR TEST


(820723MS7)


(820721MS20)


(820723MS5)

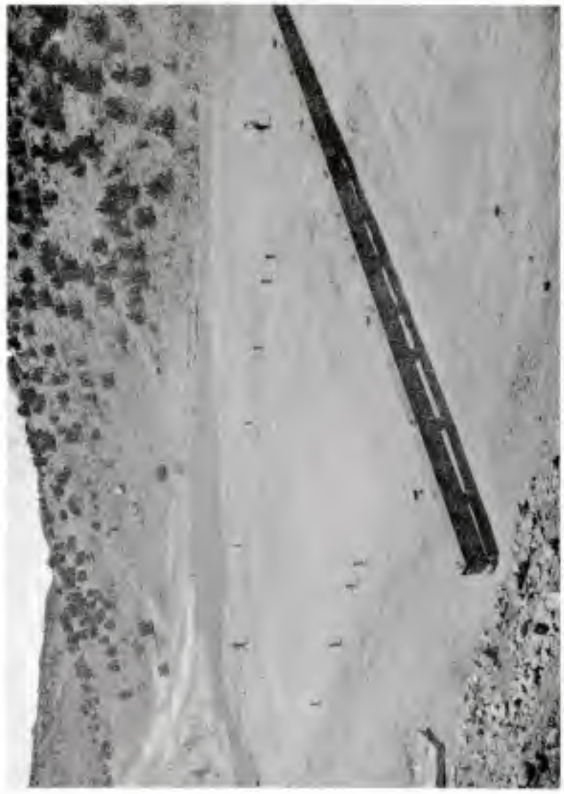

(820723MS2)

FIGURE 3-5. PRE-TEST FIELD ARRANGEMENT

Figure 3-6. The recorded times from the targets is presented in Table 3-1. The electronic data indicate a detonation velocity of 13,840 feet per second; the photographic data indicate 14,200 feet per second. The Livermore Explosives Handbook[5] indicates that for this density of flaked TNT (approximately 0.8 g/cm^3), a detonation velocity of 14,100 feet per second is expected.

Table 3-2 presents the airblast information recorded on this test. This same data, scaled to sea level conditions, is presented in Table 3-3 and plotted in Figure 3-7.

The external airblast is somewhat different than what would be expected from a spherical charge in free-air. The pressures occurring in the 30 to 50 foot range (measured off the side from the center of the donor) are similar to free-air. However, at larger distances, the pressure decays faster than from a spherical charge. This is to be expected, since the measurements are made off the side off an extended "line charge." Close-in, the pressures will be less than predicted in free-air due to the "mass-effect" of the enclosure.[6] This is shown as the dotted extrapolation in Figure 3-7.

Pressures were also measured at two locations inside the enclosure--at the center of the gap and at the start of the acceptor. Because of the extreme thermal environment, these records are difficult to interpret. These results are also presented in Tables 3-2 and 3-3. As can be seen the pressure at the acceptor is about 1000 psi--more than an order of magnitude less than that required for shock initiation. Appendix B presents the airblast pressure-time waveforms recorded on this test.

None of the detonation probes in the acceptor were triggered. All were recovered intact after the shot. The high speed photographs indicated a fireball proceeding along the conveyor. The fireball did not propagate over the entire acceptor length--it stopped about 20 feet from the end. The film also showed unreacted TNT and apparently undamaged conveyor material being thrown from the enclosure. After the shot, there was considerable evidence that the acceptor did not detonate: (1) there was over 70 feet of conveyor material remaining intact; (2) there was a crater running the length of the donor, none under the acceptor; (3) unreacted TNT was recovered; and (4) a large portion of the structure remained intact.

Figures 3-8 and 3-9 are series of photographs of the post-test conditions. There was some burning of the acceptor TNT; however, it quickly extinguished itself. This is evidenced by the discolored area on the ground around the acceptor.

Pieces of the conveyor enclosure were thrown several hundred feet. The locations and ranges of the larger pieces are shown in Table 3-4.

---

[5]Dobratz, B. M., "LLNL Explosives Handbook - Properties of Chemical Explosives and Explosive Simulants," UCRL 52997, 16 Mar 1981.

[6]Porzel, F. B., "An Introduction to the Unified Theory of Explosions," NOL TR 72-209.

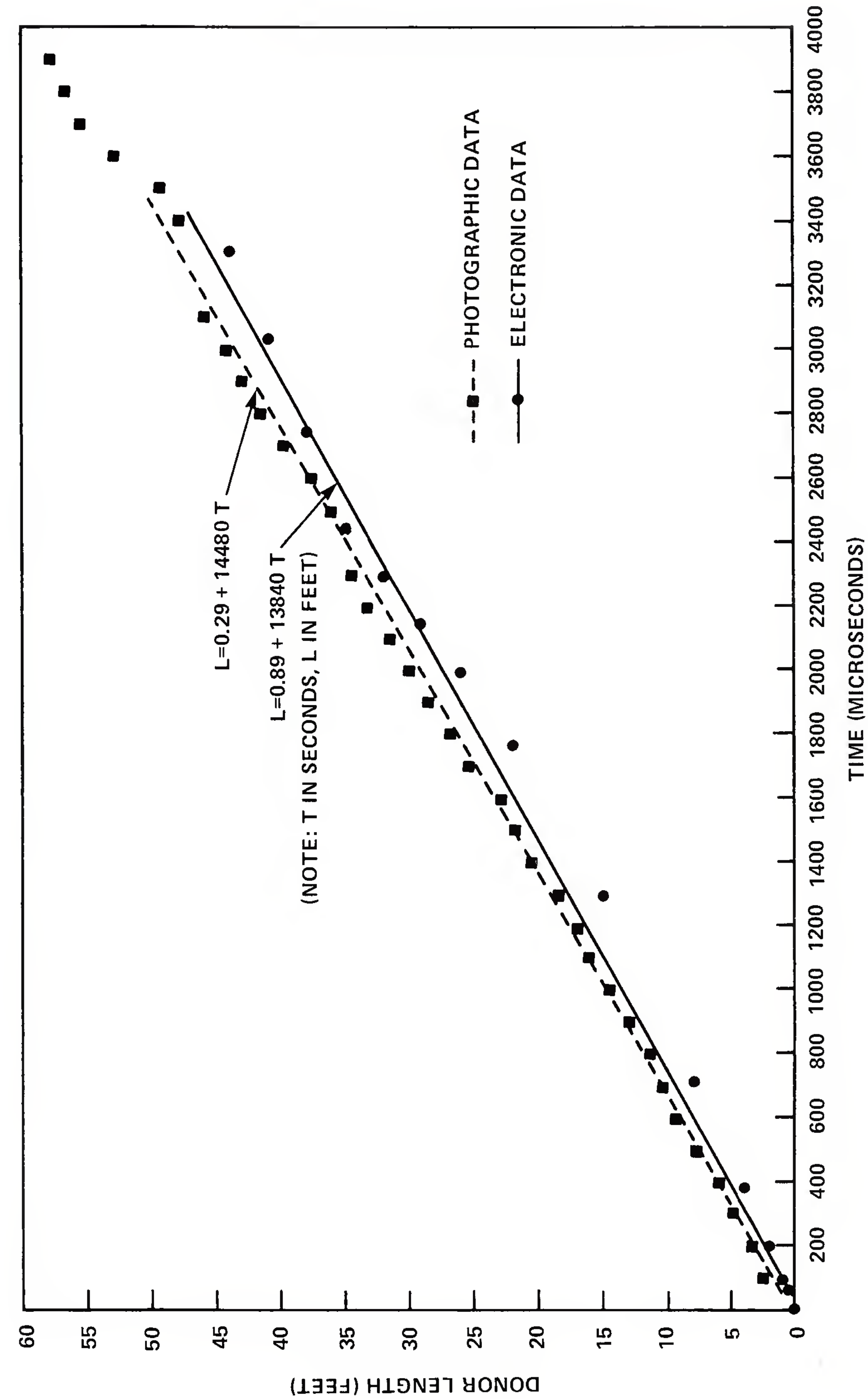


FIGURE 3-6. SHOCK FRONT POSITION-TIME (ENCLOSED CONVEYOR)

TABLE 3-1. SHOCK FRONT POSITION TIME (ENCLOSED CONVEYOR)

Target Number	Polarity	Position* (ft)	Arrival Time (Microseconds)
1	positive	0	0
2	negative	0.5	60
3	positive	1.0	95
4	negative	2.0	200
5	positive	4.0	380
6	negative	8.0	715
7	positive	15.0	1295
8	negative	22.0	1760
9	positive	26.0	1985
10	negative	29.0	2140
11	positive	32.0	2290
12	negative	35.0	2440
13	positive	38.0	2740
14	negative	41.0	3035
15	positive	44.0	3320
16	negative	47.0	----

*Measured from detonation end

TABLE 3-2. AIRBLAST PARAMETERS MEASURED AT TEST SITE (ENCLOSED CONVEYOR)

Channel	Angle*	Range**	Peak Pressure (psi)	Positive Impulse (psi-ms)	Positive Duration (ms)	Time of Arrival of Fragments (ms)	Time of Arrival of Shock (ms)
2-4	90°	38.0	21.2	43.0	6.82	-----	17.72
1-1	90°	44.0	----	----	-----	-----	-----
1-2	90°	63.0	10.8	29.6	7.47	-----	33.07
1-3	90°	88.0	5.7	18.9	8.10	48.67	51.17
1-4	90°	138.0	3.0	12.6	9.25	58.84	89.97
2-5	135°	84.1	----	----	-----	-----	-----
1-11	135°	87.0	4.0	----	-----	-----	43.47
1-12	135°	98.0	----	----	5.75	-----	53.62
2-2	135°	115.6	3.5	9.92	10.14	-----	68.34
2-3	135°	157.1	2.2	10.30	11.70	-----	99.47
1-5	135°	12.5***	98.0	----	-----	-----	4.858
1-6	135°	25.0***	----	----	-----	-----	8.505

*0° is point of detonation
**Measured from center of donor charge
***Measured from end of donor

TABLE 3-3. AIRBLAST PARAMETERS SCALED TO SEA LEVEL CONDITIONS (ENCLOSED CONVEYOR)

Channel	Angle*	Range**	Peak Pressure (psi)	Positive Impulse (psi-ms)	Positive Duration (ms)	Time of Arrival of Fragments (ms)	Time of Arrival of Shock (ms)
2-4	90°	35.7	25.6	50.1	6.58	-----	17.12
1-1	90°	41.3	----	----	-----	-----	-----
1-2	90°	59.2	13.1	34.5	7.22	-----	31.95
1-3	90°	82.7	6.83	22.0	7.83	47.02	49.44
1-4	90°	129.6	3.7	14.7	8.94	56.85	86.93
2-5	135°	79.0	----	----	-----	-----	-----
1-11	135°	81.7	4.9	----	-----	-----	42.00
1-12	135°	92.1	----	----	5.56	-----	51.81
2-2	135°	108.6	4.2	11.60	9.80	-----	66.03
2-3	135°	147.6	2.7	12.00	11.30	-----	96.11
1-5	135°	12.5***	1180	----	-----	-----	4.69
1-6	135°	25.0***	----	----	-----	-----	8.22

*0° is point of detonation
**Measured from center of donor charge
***Measured from end of donor

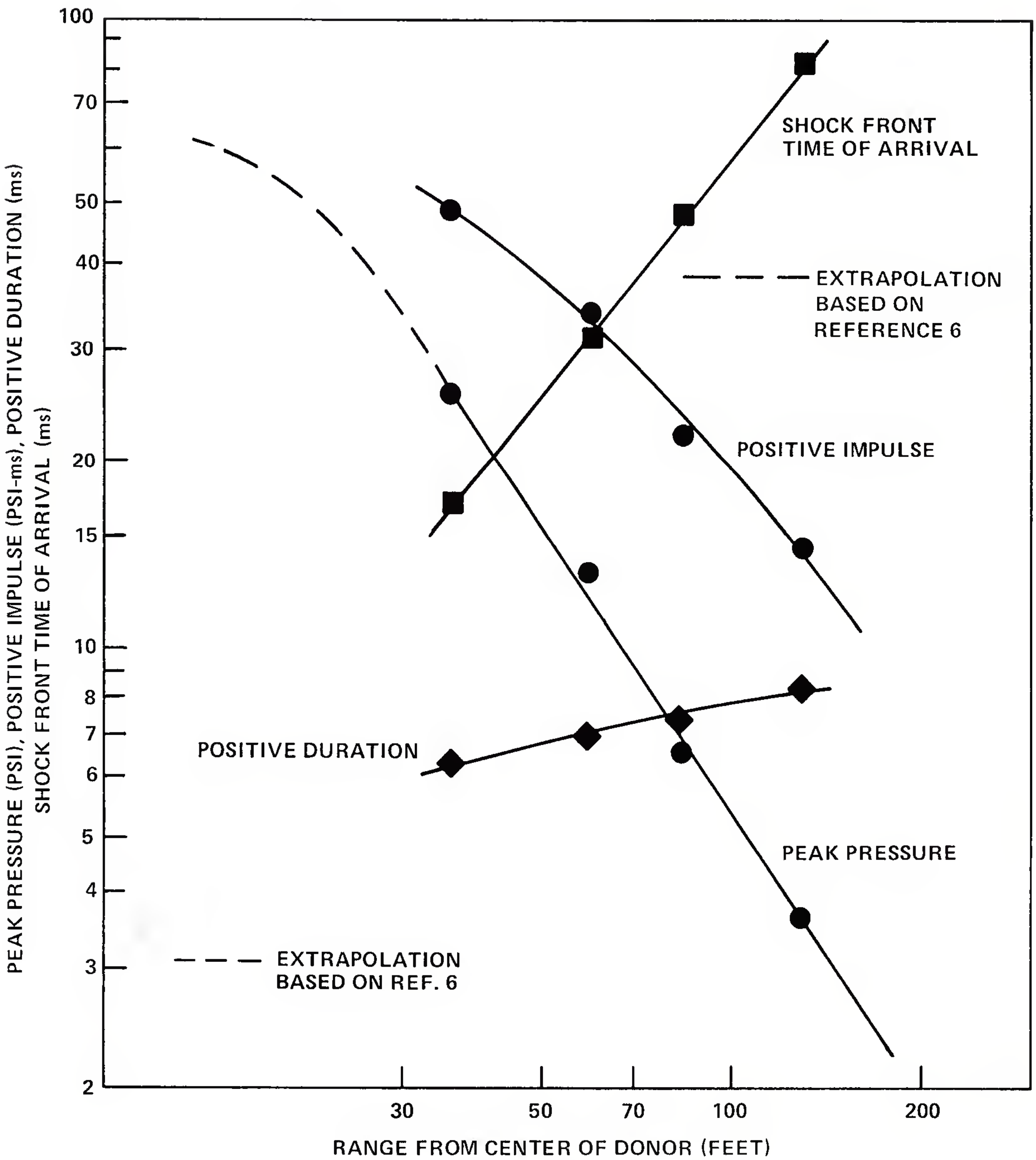


FIGURE 3-7. AIRBLAST PARAMETERS MEASURED FROM ENCLOSED CONVEYOR

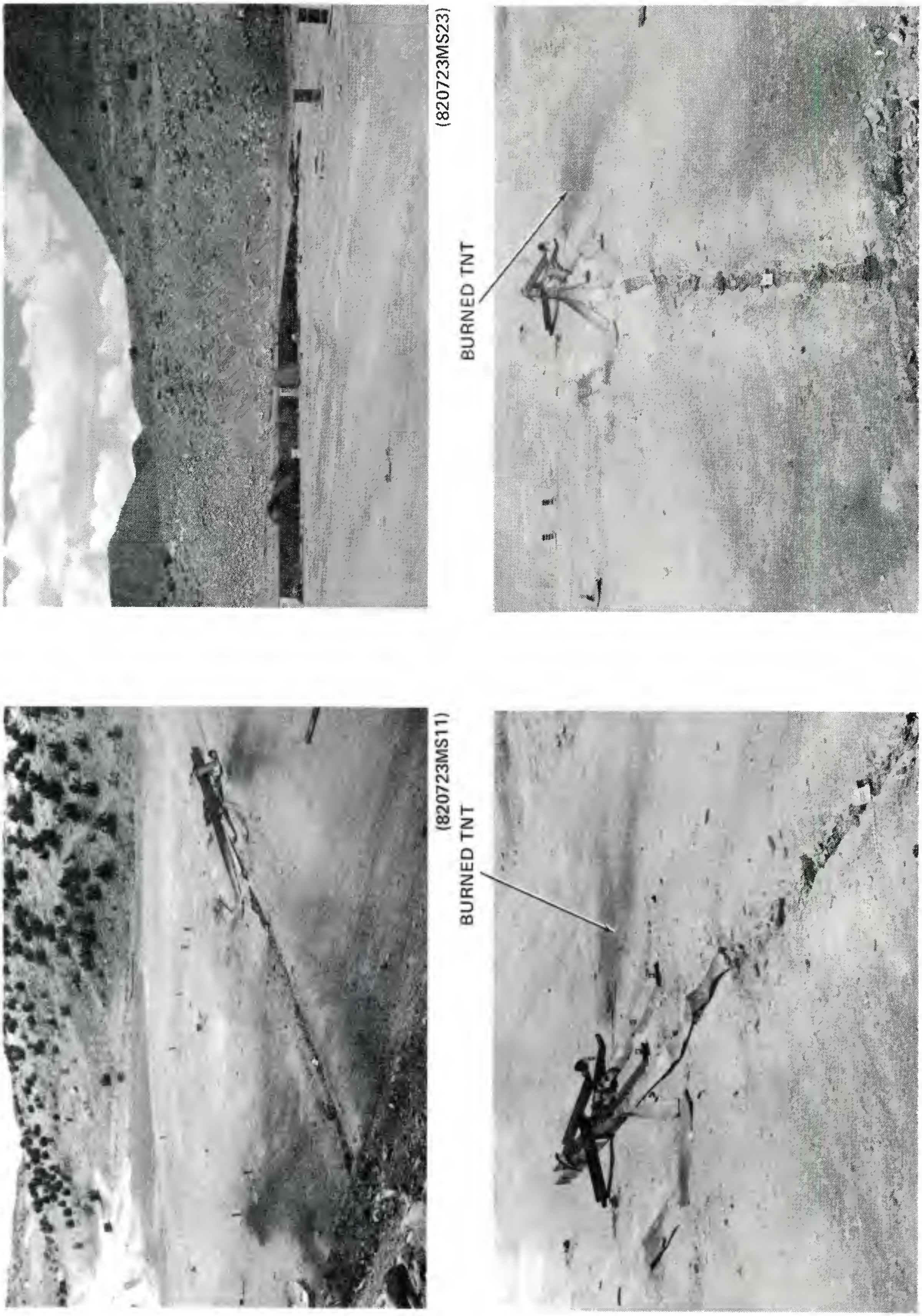


FIGURE 3-8. POST TEST RESULTS

(820723MS19)

(820723MS20)

(820723MS17)

FIGURE 3-9. POST TEST RESULTS

TABLE 3-4. APPROXIMATE POSITIONS OF RECOVERED CONVEYOR PARTS

10-FT LONG SIDE PANELS FROM LID ABOVE DONOR			10-FT LONG SIDE PANELS FROM BOTTOM PORTION OF CONVEYOR ADJACENT TO DONOR			10-FT LONG PANELS FROM TOP OF LID ABOVE DONOR		
DIRECTION	RADIUS (FEET)	ANGLE** (DEGREES)	DIRECTION	RADIUS (FEET)	ANGLE (DEGREES)	DIRECTION	RADIUS (FEET)	ANGLE (DEGREES)
SOUTH	1100	+5	SOUTH	800	–2	NORTH	775	+3
SOUTH	1000	–2	SOUTH	750	+5			
SOUTH	790	–2	SOUTH	710	+1			
SOUTH	790	0	SOUTH	680	+8			
NORTH	640	+5	SOUTH	680	–2			
NORTH	760	0	NORTH	450	0			
NORTH*	640	+3	NORTH	600	+2			
NORTH*	750	+2	NORTH*	750	–2			

*5-FT LONG PANEL

**ANGLE WAS MEASURED WITH RESPECT TO THE CENTER OF LENGTH OF THE CONVEYOR. (+) SIGN INDICATES ANGLE IS AWAY FROM INITIATION END; (–) IS TOWARD INITIATION END.

CHAPTER 4

SUMMARY

It should be remembered that the purpose of this test was not to prove that flaked TNT in the McAlester conveyor configuration would not detonate; rather, the test was designed to show the consequence of such a detonation on adjacent TNT increments. The NWC tests had already demonstrated that flaked TNT could be initiated. The current test arrangement was designed to provide an initiation of sufficient energy input to cause complete detonation of the donor charges. This test demonstrated that even with the full detonation of the donor charge, the acceptor did not detonate.

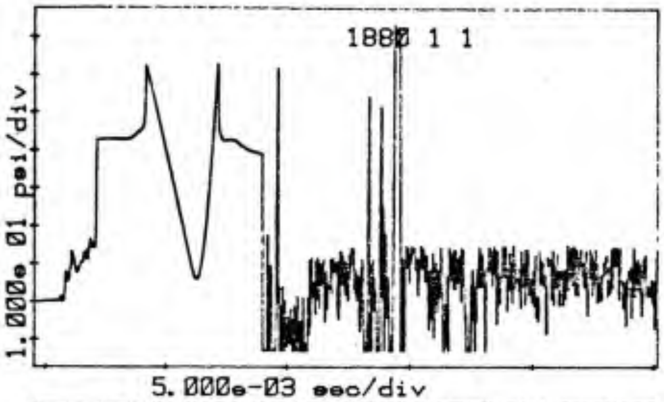
It should be remembered that this was the result of a single test, so that a statistical estimate of reliability cannot be made. However, all of the initation stimuli incident on the acceptor were of such low levels, that it is extremely unlikely that the acceptor would ever detonate under such circumstances.

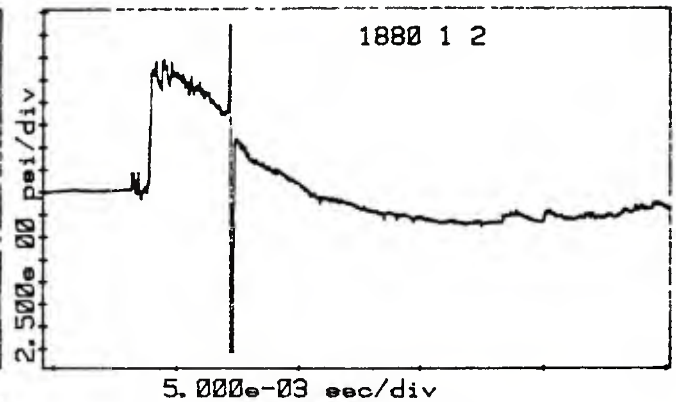
To achieve full detonation of the donor increment a very high energy input was required. A shock from 117 grams of DETA SHEET explosives (approximately a 300 kilojoule pulse) was utilized. This energy level is significantly higher than those attainable in normal handling accidents--crushing, pinching, etc.

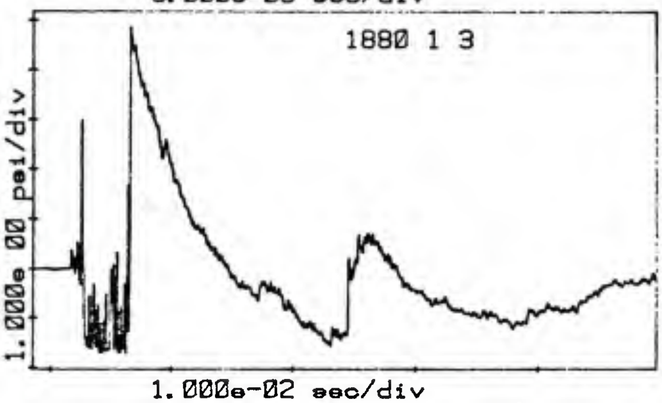
The effects on adjacent conveyors have not been addressed in this study. Based on the results of this and the NWC study, such effects should now be easily calculable.

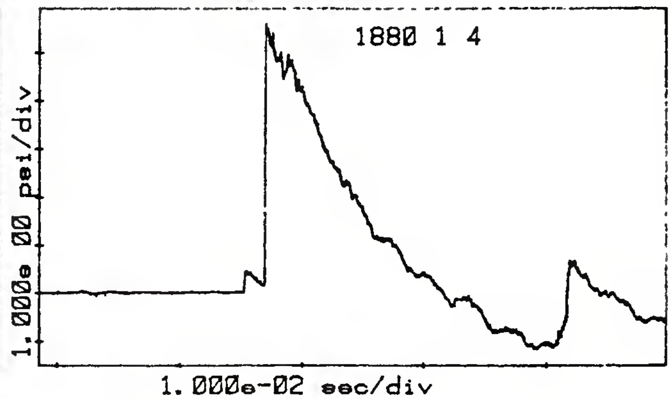
APPENDIX A

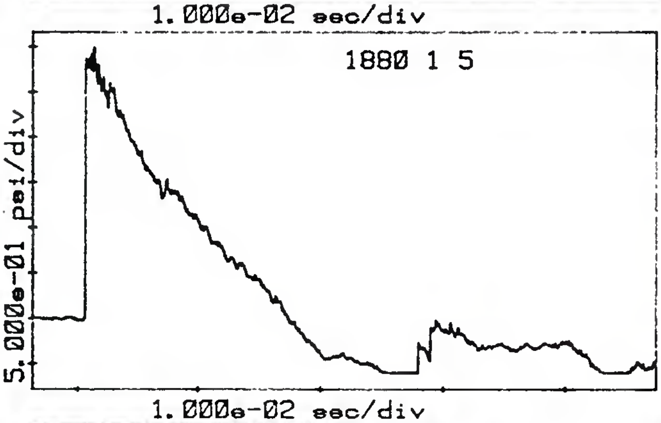
AIRBLAST PRESSURE-TIME RECORDS RECORDED ON CALIBRATION SHOT

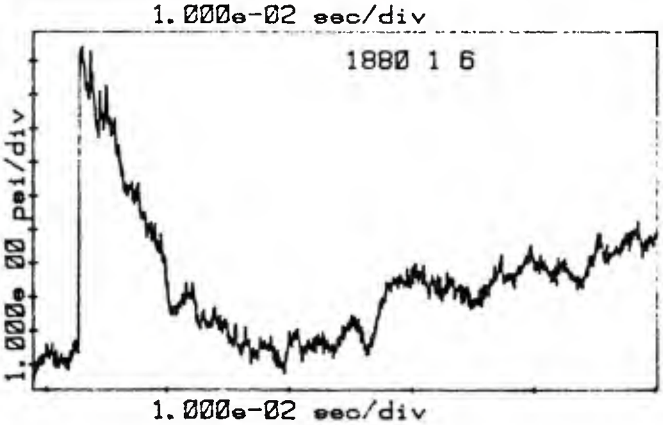

1880 1 1
1.000e 01 psi/div
5.000e-03 sec/div

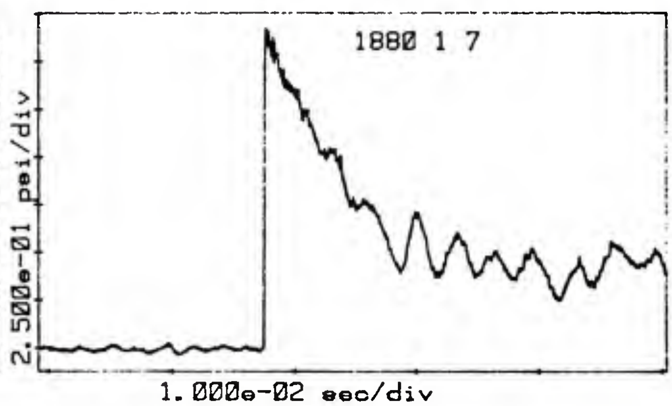

1880 1 2
2.500e 00 psi/div
5.000e-03 sec/div


1880 1 3
1.000e 00 psi/div
1.000e-02 sec/div


1880 1 4
1.000e 00 psi/div
1.000e-02 sec/div

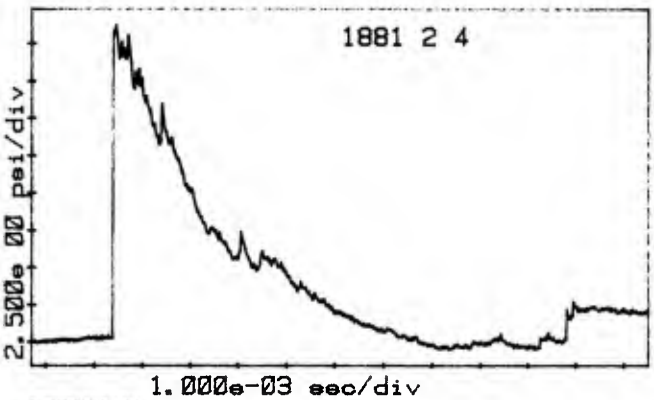

1880 1 5
5.000e-01 psi/div
1.000e-02 sec/div

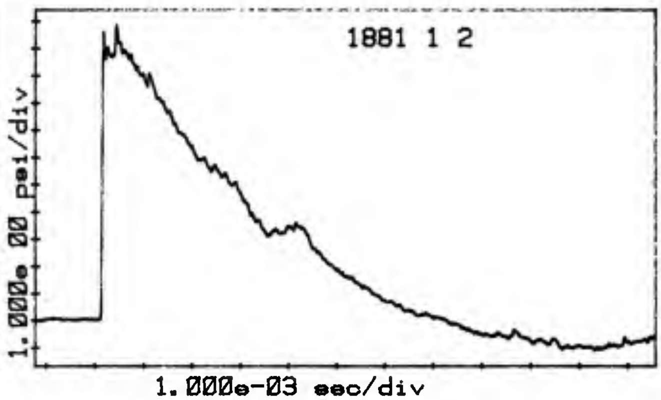

1880 1 6
1.000e 00 psi/div
1.000e-02 sec/div

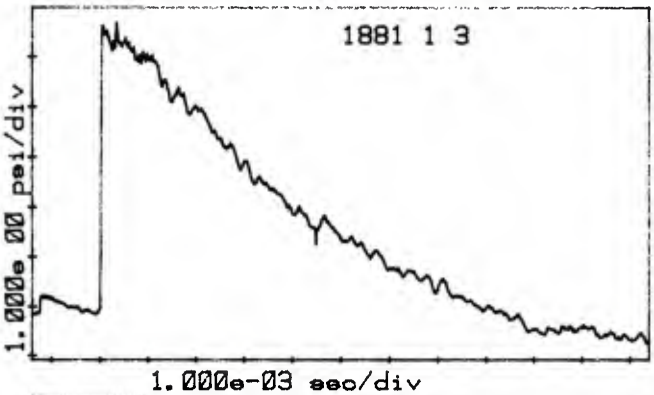

1880 1 7
2.500e-01 psi/div
1.000e-02 sec/div

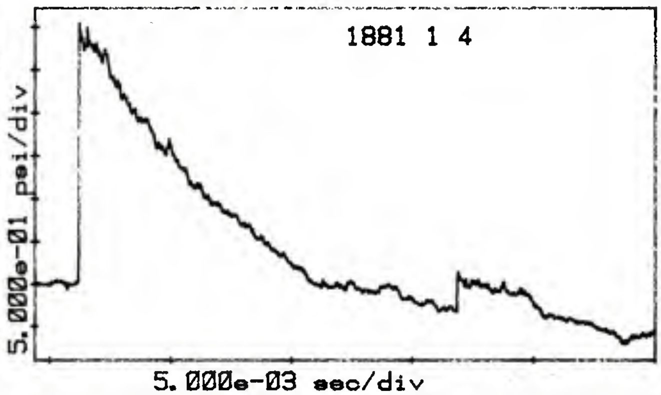
APPENDIX B

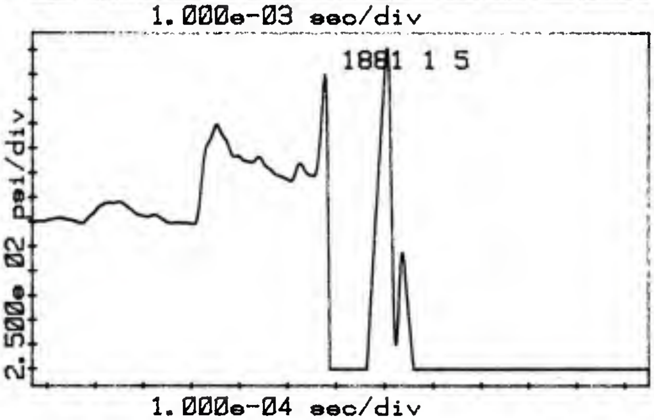
AIRBLAST PRESSURE-TIME RECORDS RECORDED ON THE ENCLOSED CONVEYOR TEST

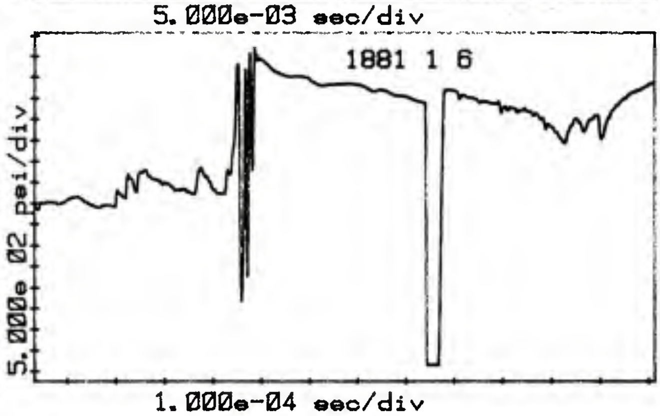

1881 2 4
2.500e 00 psi/div
1.000e-03 sec/div

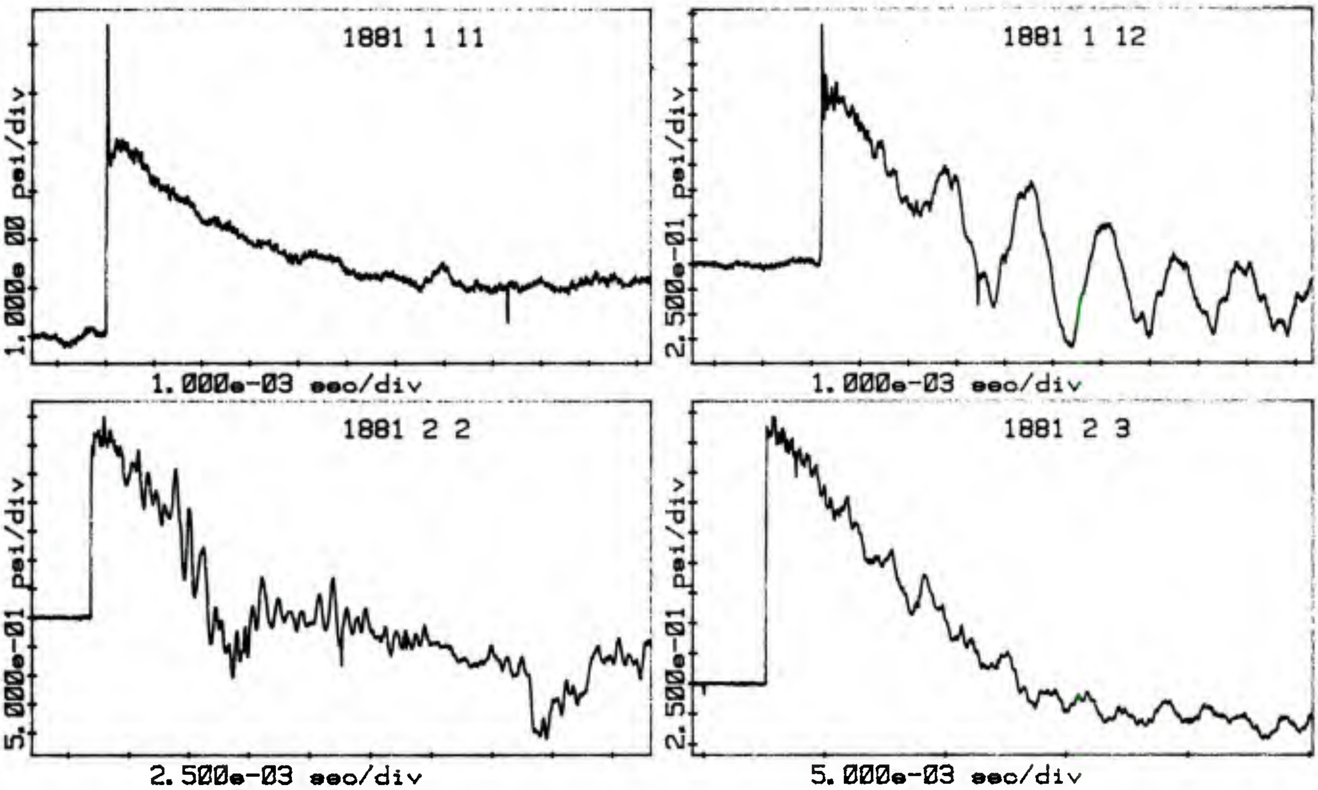

1881 1 2
1.000e 00 psi/div
1.000e-03 sec/div


1881 1 3
1.000e 00 psi/div
1.000e-03 sec/div


1881 1 4
5.000e-01 psi/div
5.000e-03 sec/div


1881 1 5
2.500e 02 psi/div
1.000e-04 sec/div


1881 1 6
5.000e 02 psi/div
1.000e-04 sec/div


1881 1 11
1.000e 00 psi/div
1.000e-03 sec/div
1881 1 12
2.500e-01 psi/div
1.000e-03 sec/div
1881 2 2
5.000e-01 psi/div
2.500e-03 sec/div
1881 2 3
2.500e-01 psi/div
5.000e-03 sec/div

DISTRIBUTION

	Copies
Chief of Naval Material Department of the Navy Washington, DC 20360	1
Chief of Naval Operations Attn: NOP-411 Department of the Navy Washington, DC 20350	1
Chief of Naval Research 800 N. Quincy Street Arlington, VA 22217	1
Commander Naval Air Systems Command Naval Air Systems Command Headquarters Washington, DC 20361	1
Commander Naval Electronics Systems Command Naval Electronics Systems Command Headquarters Washington, DC 20360	1
Commander Naval Facilities Engineering Command Naval Facilities Engineering Command Headquarters Alexandria, VA 22332	1

	Copies
Commander Naval Sea Systems command	
Attn: SEA-06H	1
SEA-06H11	1
SEA-06H12	1
SEA-06H13	1
SEA-62R	1
SEA-64E	1
SEA-6412	1
SEA-99612 (Library)	2
Naval Sea Systems Command Headquarters Washington, DC 20362	
Officer-in-Charge Civil Engineering Laboratory Naval Construction Battalion Center Port Hueneme, CA 93043	1
Commanding Officer Naval Research Laboratory Attn: Technical Information Section Washington, DC 20375	1
Commander David W. Taylor Naval Ship Research and Development Center Attn: Library Bethesda, MD 20084	1
Commander Naval Weapons Center Attn: Library China Lake, CA 93555	1
Commander Naval Weapons Station Yorktown, VA 23691	1

DISTRIBUTION (Cont.)

	Copies
Commanding Officer Naval Weapons Support Center Crane, IN 47522	1
Commanding Officer Aberdeen Research and Development Center Attn: Technical Library Aberdeen, MD 21005	1
Commander Harry Diamond Laboratories Attn: Technical Library 2800 Powder Mill Road Adelphi, MD 20783	1
Commandant Industrial College of the Armed Forces Attn: Document Control Ft. Leslie J. McNair Washington, DC 20315	1
Commandant National War College Attn: Class. Rec. Library Ft. Leslie J. McNair Washington, DC 20315	1
Headquarters Air Force Systems Command Andrews Air Force Base Attn: Technical Library Washington, DC 20331	1
Commander Air Force Weapons Laboratory Kirtland Air Force Base Albuquerque, NM 87117	1
Commander Armament Development and Test Center Attn: DLOSL, Technical Library Eglin Air Force Base, FL 32542	1
Air Force Cambridge Research Laboratories Attn: Library L. G. Hanscom Field Bedford, MA 01730	1
Air University Library Attn: Documents Section Maxwell Air Force Base, AL 26112	1
Defense Technical Information Center Cameron Station Alexandria, VA 22314	12
Director of Defense Research and Engineering Attn: Technical Library Washington, DC 20330	1
Chairman Department of Defense Explosives Safety Board Attn: DDESB-KT Room 856-C Hoffman Bldg. 1 2461 Eisenhower Avenue Alexandria, VA 22331	1
Director Defense Nuclear Agency Attn: Technical Library Washington, DC 20305	1
Commander Field Command Attn: FCTOH Defense Nuclear Agency Kirtland Air Force Base, NM 87115	1
Battelle Memorial Institute 505 King Avenue Columbus, OH 43201	1
Denver Research Institute Mechanical Sciences and Environmental Engineering Attn: J. Wisotski University of Denver Denver, CO 80210	1
Kaman-Tempo Attn: J. Petes 2560 Huntington Avenue Alexandria, VA 22303	1

DISTRIBUTION (Cont.)

	Copies
Hercules Incorporated Box 98 Magna, UT 84044	1
Hercules Incorporated Allegany Ballistics Laboratory Attn: T. Groce P.O. Box 210 Cumberland, MD 21502	1
IIT Research Institute 10 West 35th Street Attn: Technical Library Chicago, IL 60616	1
Institute for Defense Analyses Attn: Library 400 Army-Navy Drive Arlington, VA 22202	1
Kaman Sciences Corporation P.O. Box 7463 Colorado Springs, CO 80907	1
Los Alamos National Laboratory Attn: LANL Library P.O. Box 1663 Los Alamos, NM 87544	1
New Mexico Institute of Mining and Technology TERA Socorro, NM 87801	1
Pittsburgh Mining and Safety Research Center U. S. Bureau of Mines 4800 Forbes Avenue Pittsburgh, PA 15213	1
Sandia National Laboratories Attn: Library P.O. Box 5800 Albuquerque, NM 87115	1
Southwest Research Institute P.O. Drawer 28510 San Antonia, TX 78284	1

	Copies
University of California Lawrence Livermore National Laboratory P.O. Box 808 Livermore, CA 94550	1

Internal Distribution:

R	1
R10 (J. F. Proctor)	1
R15 (J. F. Pittman)	1
R15 (M. Swisdak)	5
R15 (P. Peckham)	5
R15 (G. Martin)	1
R15 (F. Porzel)	1
R15 (J. Ward)	1
R15 (R. Lorenz)	1
R15 (J. Connor)	1
R12 (W. Filler)	1
R12 (L. Roslund)	1
R12 (F. Menz)	1
R12 (M. Stosz)	1
R10 (D. Price)	1
R13 (R. Bernecker)	1
E431	9
E432	3
E35	1